EARTH OBSERVING SYSTEM
GEOSCIENCE LASER ALTIMETER SYSTEM

GLAS I-SIPS Software Architectural Design Document

Version 2.0

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Contact:

B. E. Schutz, schutz@utcsr.ae.utexas.edu
GLAS Science Team

EOS

Foreword

This document describes the architectural design of the GLAS (Geoscience Laser Altimeter System) Science Software, referred to herein as the I-SIPS (ICESat Science Investigator-led Processing System) Software. The I-SIPS Software supports the GLAS instrument on the NASA EOS (Earth Observing System) ICESat (Ice, Cloud, and land Elevation Satellite) Spacecraft.

This document has been prepared by the GLAS Science Software Development Team (SDT) of NASA Goddard Space Flight Center. It was prepared in support of Dr. Bob E. Schutz, Science Team Leader of the GLAS Science Investigation. The development of this document was accomplished under the direction of David W. Hancock III, SDS Development Team Leader; he may be contacted at hancock@osb.wff.nasa.gov (e-mail), (757) 824-1238 (voice), or (757) 824-1036 (fax).

Document Change History

Document Name: GLAS I-SIPS Software Architectural Design Document		
Version Number	**Date**	**Nature of Change**
Version 0.5	July 1998	Preliminary Draft
Version 1.0	September 1998	Initial Release
Version 2.0	October 1998	Revised the DFDs and the Associated Text

Items to be Resolved

1) One original software requirement (GSDP-31500) and two goal software requirements (GSDP-31600 and GSDP-31700), included in Table 6-1, are not specifically addressed in the text.
2) Refine the contents of each s/w delivery.

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Preface

Within the four volumes of NASA software engineering documentation [Reference: Applicable Document 2.2a], this Architectural Design Document is a roll-out of Volume 2 (the Product Specification Volume) for the GLAS Science Software. It is configured and maintained as an informal[1] part of the GLAS Science Software Delivery Package. Its purpose is to serve as the prerequisite document for the GLAS I-SIPS Software Detailed Design Document (ISDDD).

1. A Software Architectural Design Document is not explicitly listed as a deliverable component of the GLAS Science Software Delivery Package, but is included as a part of the structured software engineering approach described in the GLAS Science Software Management Plan (SSMP) [Reference: Parent Document 2.1a]. It is therefore identified as an informal rather than a formal (required) Project deliverable.

Section 1
Introduction

1.1 Identification of Document

This document describes the architectural design of the GLAS Science Software, referred to herein as the I-SIPS (ICESat-Science Investigator-led Processing System) Software. It is a roll-out of Volume 2 (the Product Specification Volume) of the four volumes of NASA software engineering documentation [Reference: Applicable Document 2.2a] and is specified as a deliverable by the I-SIPS Software Documentation Tree in the GLAS Science Software Management Plan (SSMP) [Reference: Parent Document 2.1a]. It is identified as the GLAS Science Software Architectural Design Document (SSADD).

Subsequent editions of this document will be uniquely identified by document version and date marks on the cover and individual page footers.

1.2 Scope of Document

This document describes the conceptual design and the logical design of the I-SIPS Software. The I-SIPS Software is a subsystem of the GLAS Standard Data Software (SDS). The I-SIPS Software produces Level 1A, Level 1B, and Level 2 data products as well as associated product quality assessments.

This document is written by the SDS Development Team (SDT) under the direction of the SDT Leader. Its content and format are in accordance with NASA software engineering standards [Reference: Applicable Document 2.2a]. The architectural design of the I-SIPS Software is in accordance with the GLAS SSMP [Reference: Parent Document 2.1a]. The architectural design process proceeds from the requirements definition process, and precedes and overlaps the detailed design process as defined in the software development life cycle [Reference: Parent Document 2.1a]. It is the function of the architectural design process, and therefore of this document, to provide a foundation for the detailed design process.

The level of depth, detail, and maturity differentiates the architectural design from the detailed design. The architectural design presents an earlier, less mature depiction of the logical aspects of the software. Further, the architectural design is top-level, avoiding unnecessary commitment to detail. The GLAS SSMP [Reference: Parent Document 2.1a] and the NASA Software Documentation Standard Software Engineering Program [Reference: Applicable Document 2.2c] mandate a decomposition of the logical design to at least one level for the architectural design. Decomposition of software functions to the lowest level elements is relegated to the detailed design process.

1.3 Purpose and Objectives of Document

The purpose of this document is to specify the architectural design of the I-SIPS Software. This document addresses the outline topics included in the architectural design template of the NASA Software Documentation Standard Software Engineering Program [Reference: Applicable Document 2.2a].

The following objectives are identified for this architectural design specification of the I-SIPS Software:

- to define the design approach;
- to identify and list the drivers (i.e., driving factors) and constraints influencing the design;
- to present the conceptual architecture;
- to present the logical architecture;
- to define the external interface specifications and to allocate the external interfaces to the software processes defined by the architectural design;
- to allocate the applicable SDS requirements and the I-SIPS Software requirements enumerated in the GLAS SSRD[1] [Reference: Parent Document 2.1c] across the architectural design and to show the traceability of the requirements and constraints to components of the architectural design; and
- to specify the functional components to be satisfied by each scheduled software delivery.

1.4 Document Status and Schedule

This document is the Initial Release of the GLAS SSADD. Subsequent editions of the document will include any updated Project, instrument, and Science Team design specifications.

1.5 Documentation Organization

The organization of this document is based on the Architectural Design section of the Product Specification Volume described in the NASA Software Documentation Standard Software Engineering Program [Reference: Applicable Document 2.2a].

Sections 1 and 2 contain the introductory and reference document information. Section 3 describes the design rationale and developmental trade-offs. Section 4 contains the architectural design description of the software system and includes decomposition to at least one level. Section 5 develops the relationships and descriptions of the software external interfaces, including both design and allocation subsections. Sec-

1.The GLAS SSRD [Reference: Parent Document 2.1c] enumerates the GLAS Science Data Software (SDS), the I-SIPS Software, and the GLAS Instrument Support Terminal (IST) Software requirements. The GLAS IST software requirements are not implemented in the I-SIPS Software or addressed in this document.

tion 6 describes the allocation of the software requirements to the software design. Section 7 addresses the partitioning of the software requirements and functions for incremental deliveries of the software.

Supplemental information is presented in the Abbreviations and Acronyms and in the Glossary sections. Any upper level section and sub-section headings from the document standards template that are not populated with information or are not germane to the scope of this document are identified as not applicable (N/A). Any sections or sub-sections that are extraneous to the standard outline are denoted as additions.

Section 2
Related Documentation

This section provides the references for the GLAS ISADD. Document references include parent documents, applicable documents, and information documents.

2.1 Parent Documents

Parent documents are those external, higher-level documents that contribute information to the scope and content of this document. The following GLAS documents are parent to this document.

a) *GLAS Science Software Management Plan* (GLAS SSMP), Version 2.2, July 1998, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-SMP-1100.

b) *GLAS Science Data Management Plan* (GLAS SDMP), Version 2.2, July 1998, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-DMP-1200.

c) *GLAS Science Software Requirements Document* (GLAS SSRD), Version 1.2, July 1998, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-PRS-2100.

The GLAS SSMP is the top-level Volume 1 (Management Plan Volume) document of the four volumes of NASA software engineering documentation [Applicable Reference 2.2c]. It dictates the creation and maintenance of the Product Specification Volume (Volume 2). This document is a roll out of the Product Specification Volume.

2.2 Applicable Documents

Applicable documents include reference documents that are not parent documents. This category includes reference documents that have direct applicability to, or contain policies binding upon, or information directing or dictating the content of this document. The following GLAS, EOS Project, NASA, or other Agency documents are cited as applicable to this architectural design document.

a) *NASA Software Documentation Standard Software Engineering Program*, NASA, July 29, 1991, NASA-STD-2100-91.

b) *Science User's Guide and Operations Procedure Handbook for the ECS Project, Volume 4: Software Developer's Guide to Preparation, Delivery, Integration and Test with ECS*, Final, August 1995, Hughes Information Technology Corporation, 205-CD-002-002.

c) *Data Production Software and Science Computing Facility (SCF) Standards and Guidelines*, January 14, 1994, Goddard Space Flight Center, 423-16-01.

d) *EOS Output Data Products, Processes, and Input Requirements*, Version 3.2, November 1995, Science Processing Support Office.

e) *NASA Earth Observing System Geoscience Laser Altimeter System GLAS Science Requirements Document,* Version 2.01, October 1997, Center for Space Research, University of Texas at Austin.

f) *Precision Orbit Determination (POD),* Algorithm Theoretical Basis Document, Version 0.1, December 1996, Center for Space Research, The University of Texas at Austin.

g) *Atmospheric Delay Correction to GLAS Laser Altimeter Ranges,* Algorithm Theoretical Basis Document, Version 0.3, December 1996, Massachusetts Institute of Technology.

h) *Algorithm Theoretical Basis Document for the GLAS Atmospheric Channel Observations,* Version 0 (Preliminary), December 1995, Goddard Space Flight Center.

i) *Geoscience Laser Altimeter System: Surface Roughness of Ice Sheets,* Algorithm Theoretical Basis Document, Version 0.3, December 1996, University of Wisconsin.

j) *Determination of Sea Ice Surface Roughness from Laser Altimeter Waveform,* Algorithm Theoretical Basis Document, Version 0 (Preliminary), December 1995, The Ohio State University.

k) *Laser Footprint Location and Surface Profiles*, Algorithm Theoretical Basis Document, Version 0 (Preliminary), December 1996, Center for Space Research, The University of Texas at Austin.

l) *Precision Attitude Determination (PAD)*, Algorithm Theoretical Basis Document, December 1996, Center for Space Research, The University of Texas at Austin.

m) *GLAS Level 0 Instrument Data Product Specification*, Version 2.2, March 17, 1998, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-DPS-2610.

n) *GLAS Standard Data Products Specification - Level 1*, Version 1.2, March 17, 1998, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-DPS-2621.

o) *GLAS Standard Data Products Specification - Level 2*, Version 1.2, March 17, 1998, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-DPS-2641.

2.3 Information Documents

Information documents are those that are not directly applicable as a reference to this architectural design document. They are documents providing information to amplify or clarify architectural design information contained in this document.

The following EOS Project, NASA, or other Agency documents are cited as providing background or supplemental information to this architectural design document.

a) *Operations Concept for Integration and Test of Science Data Production Software*, White Paper, March 1995, Hughes Applied Information Systems, Inc., 62-WP-001-002.

b) *Interface Control Document Between EOSDIS Core System (ECS) and Science Computing Facilities (SCF)*, December 1995, Hughes Information Technology Corporation, 209-CD-005-504.

c) *SDP Toolkit Users Guide for the ECS Project*, August 1995, Hughes Information Technology Corporation, 333-CD-003-002.

d) *Structured Design*, 1978, E. Yourdon & L. L. Constantine, Yourdon Press

Information documents 2.3a, 2.3b, and 2.3c provide non-binding information concerning the Science Data Production (SDP) Toolkit and the Science Computing Facility (SCF). Information document 2.3d is a non-binding reference for the structured design methodology and guidelines.

Section 3
Design Approach and Tradeoffs

3.1 Design Approach

The architectural design of the I-SIPS Software utilizes a structured design approach following the Yourdon and DeMarco methodology. In this approach, the major functions of the system are identified and decomposed into processes to obtain the logical architecture.

The architectural design described in this document provides the high-level definition of the system. In the I-SIPS Software Detailed Design Document (ISDDD), the detailed design will provide the lower-level description of the functions defined in the architectural design.

3.1.1 Rationale for Design Approach

The structured design methodology was used by the GLAS SDS Development Team (SDT) to optimize the software architectural design within the software requirements and constraints. Software developed from a structured design is typically characterized by efficiency, reliability, maintainability, modularity, and utility. Additionally, a structured design approach is consistent with the GLAS SSMP software engineering life cycle [Reference: Parent Document 2.1a].

3.1.2 Approach to Managing The Design Effort

Following are the guidelines adopted for managing the I-SIPS Software design effort. These guidelines expand on those delineated in the GLAS SSMP [Reference: Parent Document 2.1a] and in *Structured Design* by E. Yourdon and L. Constantine [Reference: Information Document 2.3d].

1) Documentation is a metric by which the Science Team determines the status of software development activities. As incremental releases of the software are developed, any required design changes will be incorporated into the design documentation.
2) The software architectural design is refined until a point of diminishing returns is reached (i.e., further changes in the design are cosmetic and provide no further benefit). At that time, with the approval of the SDT Leader, the architectural design and its associated documentation is considered complete and is delivered to the Science Team for final approval.
3) Design reviews and walkthroughs are held to provide the Science Team opportunities to observe the development in progress, to provide additional information, and to request changes.

The SDT has decided to use WIN A&D and MAC A&D for the modeling process. This COTS tool provides us the facility:

- to produce the process, state, and structure models of the system

- to integrate a data dictionary with the models
- to cross-reference variables and processes
- to trace variables and processes back to the ATBDs
- to trace the requirements through the design phase to ensure all requirements are fulfilled

Using this COTS will aid in the maintenance and testing of the software and in the documentation and labeling of the data products.

3.2 Design Decisions and Tradeoffs

This section describes the decisions and tradeoffs the SDT made which affect the design of the I-SIPS Software.

- The SDT decided to keep the Lidar and altimeter data processing streams as separate as possible so one data stream can be processed without the other. However, some parameters on the altimeter products are calculated from the Lidar products. These parameters add value to the final elevations, but are not required for altimeter product release. Therefore, these parameters will be computed from the Lidar products on an as-available basis. If the Lidar products are unavailable, the altimeter products can be produced with these parameters marked as unavailable.
- When designing the I-SIPS Software processing stream, the SDT has taken into account the need for selective reprocessing of data products due to algorithm changes or ancillary file changes. Based on the Team's previous experience with satellite radar altimeters and with aircraft and shuttle laser data post-processing, we have expectations regarding which algorithms and ancillary files will likely need to be updated. These expectations are used with the dependencies defined in the ATBDs to design the software such that specific processes can run separately from others. The SDT has designed the output products to carry additional information that will aid selective reprocessing. Reprocessing is defined in more detail in Section 4.4.
- The SDT has designed the I-SIPS Software to be independent of the ESDIS-provided SDP Toolkit. It has been agreed to deliver the GLAS data products in Hierarchical Data Format (HDF) to the ESDIS Project. The Level 1 products will be in the standard HDF while the Level 2 products will be in HDF-EOS (a special HDF developed for the EOS Project). The SDT will consider using the SDP Toolkit to format the data products in HDF, if it is available for the HP-UX. The SDT is investigating currently-available HDF formatting COTS tools.
- To ensure ease of software portability, all platform-specific components will be isolated. ANSI standard Fortran 90 and C will be used to code the I-SIPS Software. All FORTRAN code will be written in compliance with the GLAS Fortran 90 coding guidelines.

3.3 Architectural Drivers

The architectural drivers are the information sources that influence the SDT's software design decisions and tradeoffs. The architectural drivers and the software requirements influence the software system's overall conceptual model and the logical architecture.

The requirement for reprocessing as discussed in section 4.0 drives the overall design. This forces each subsystem process to be designed as its own entity, with overall controller and individual executors to govern execution of the individual processes.

In addition to the reprocessing requirement, there are other drivers that influence the architecture of the software. These drivers are discussed in he following sections.

3.3.1 Science Drivers

The science drivers originate from two sources: the Science Team and the ESDIS Project.

The Science Team defines the contents of the science data products, and produces the Algorithm Theoretical Basis Documents (ATBDs) that define the algorithms to transform the instrument measurements into the science data products. Additionally, the Science Team defines the ancillary data required to produce the science data and the quality measurements of the science data products. The SDT will use the information gathered from the science drivers to produce the science data product definitions and the I-SIPS Software which is composed of the science algorithms, their inputs and outputs.

For GLAS, the ESDIS Project is the source of the Level 0 data, is the platform for the archival and promotion of the science and ancillary data, and disseminates the GLAS data to scientific, educational, and public organizations and individuals. The ESDIS influence affects the design of the data products and the structure for incorporating the data (and metadata) into the Project archives. ESDIS Project documents detail the operation of the interfaces between ESDIS and the science data provider/user community.

3.3.2 Policy and Funding Drivers

The I-SIPS Software should be applicable to ESDIS policies and constraints. Using a structured design approach results in the I-SIPS Software being easily modifiable if changes in policies or constraints affect its operation. A decrease of funding will lead to a descoping of the I-SIPS Software.

3.3.3 Other Drivers

This section discusses the influences of software inheritance and software reusability.

A GSFC software heritage exists for the GLAS Laser Altimeter and Lidar instruments, including such systems as ATM, SLA, and MOLA. GSFC also has considerable software heritage in the related area of satellite radar altimetry, including TOPEX/POSEIDON, GEOSAT, GFO, ERS-1, and ERS-2. The software inheritance from these missions is an intuitive influence on the design process rather than in applicable software units. This inherited knowledge is useful in the logical decomposition design process.

As part of the design process, the SDT has investigated the GSFC DAAC V0 software and has decided to port it to our processors to use for data management, archive, and distribution.

Software portability and reliability are an important driving influence on software development. The GLAS Investigation hopes to produce and support a total of three flight instrument systems on EOS spacecraft platforms. The 15+ year mission support aspect requires an I-SIPS Software design which will sustain the instrument management and data production processes for GLAS throughout the full mission life span.

The development of the I-SIPS Software is specific to the GLAS Investigation.

Section 4

Architectural Design Description

This section presents the I-SIPS Software architectural design. As described in Section 3 of this document, the architectural design is composed of the conceptual architecture and the logical architecture. Each of these two design elements is described in this section. Additionally, this section describes the delineation between nominal processing and the reprocessing of selected data due to such factors as updated orbit/attitude data files, revised constants/coefficients, or modified ATBDs.

4.1 Conceptual Architecture

The first step in the architectural design process is the definition of the conceptual architecture of the software system. The I-SIPS Software conceptual architecture is illustrated in Figure 4-1 and is derived from the software requirements and constraints enumerated in the GLAS SSRD [Reference: Parent Document 2.1c]. In Figure

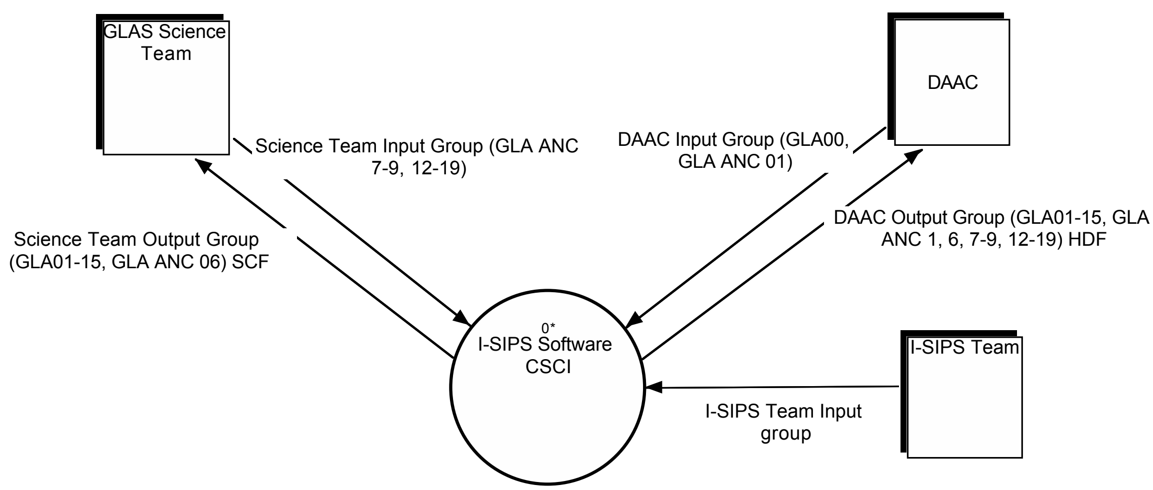

Figure 4-1 I-SIPS Software Conceptual Architecture

4-1, the conceptual architecture is illustrated using a context diagram, in which the software (the I-SIPS Software) is depicted as a circle, system external interfaces are pictured as rectangles, and data flow to and from the system external interfaces is represented by arrows indicating the direction of the data flow and labelled with data descriptors. The system external interfaces are described in Section 5 of this document. Definition of the data descriptors is provided in this section, with detailed descriptions furnished in the GLAS product specification documents [Reference: Applicable Documents 2.2m, 2.2n, and 2.2o].

4.1.1 External Interface Data

Table 4-1 provides definitions of the data descriptors depicted in Figure 4-1. The data files listed in Table 4-1 are described later in this section.

Table 4-1 External Interface Data Descriptors

External Interface	Data Descriptor	Data Files
GLAS Science Team	Science Team Input Group	GLA ANC 07 GLA ANC 08 GLA ANC 09 GLA ANC 12 GLA ANC 13 GLA ANC 14 GLA ANC 15 GLA ANC 16 GLA ANC 17 GLA ANC 18 GLA ANC 19
	Science Team Output Group	GLA ANC 06 GLA01 thru GLA15
GLAS I-SIPS Team	I-SIPS Team Input Group	Control Info
DAAC	DAAC Input Group	GLA ANC 01 GLA00
	DAAC Output Group	GLA ANC 01 GLA ANC 06 GLA ANC 07 GLA ANC 08 GLA ANC 09 GLA ANC 12 GLA ANC 13 GLA ANC 14 GLA ANC 15 GLA ANC 16 GLA ANC 17 GLA ANC 18 GLA ANC 19 GLA01 thru GLA15

The I-SIPS Software generates the GLAS Standard Data Product files, performs data product quality assessment, and produces data product metadata. Metadata is descriptive information about each data product. This information includes the data quality, data start and stop times, product creation data, input file identification, etc. Metadata also provides an assessment of the software performance. In addition metadata includes all information and data structures necessary to support installation of the data product on the DAAC and to support Archive Browse, Query, and Retrieval from the data repository.

4.2 Logical Architecture

The second step in the architectural design process is the definition of the logical architecture, where the software system (the I-SIPS Software) is decomposed into processes, the relationships between the processes are described, and the input/output data of the processes are defined. Also provided are data descriptions, timing and sequencing information, and implementation constraints. In Section 6 of this document, the applicable software requirements defined in the GLAS SSRD [Reference: Parent Document 2.1c] are allocated to the logical elements resulting from this functional decomposition.

Logical architecture is illustrated in this document through the use of a top level decomposition chart and data flow diagrams. The top level decomposition chart illustrates the logical relationship between the top level software components. Data flow diagrams illustrate the lower level decomposition and the transfer of data by depicting processes as ovals or circles, data stores as two parallel horizontal lines, and arrows indicating the direction of data flow and labeled with data descriptors.

4.2.1 Top Level Decomposition

The I-SIPS Software is decomposed into the ISIPS controller and 4 science algorithm subsystems: the Level 1A subsystem, the Level 1B waveform subsystem, the Level 1B and 2 elevation subsystem, and the Level 1B and 2 atmosphere subsystem. These components comprise a system which will perform highly automated ingestion, archiving, processing, and distribution of GLAS data. Each of the science algorithm subsystems will be divided into separate libraries executed by the ISIPS controller. This will allow for maximum flexibility for both standard processing, and re-processing scenarios. The top level decomposition of I-SIPS is shown in Figure 4-2.

4.2.2 Software Data Files

Data produced or used by the I-SIPS Software are organized into the GLAS Standard Data Product files and the GLAS Ancillary Data Product files [Reference: Parent Document 2.1b]. These files, together with the top level processes that produce them as output or use them as input, are listed in Table 4-2. (The process numbers listed in Table 4-2 correspond to the software subsystems pictured in Figure 4-3 "I-SIPS Software Data Flow Diagram" on page 4-7.) Should post-processing quality assessment (QA) of the data products be necessary those data products will marked as not validated until the QA is completed.

HDF (Hierarchical Data Format) is the file format required by EOSDIS for standard data products stored at the DAAC. The standard data products as they are stored on the ICESat SCF are not in HDF. In Table 4-2, the non-HDF versions of the GLAS Standard Data Product files have _SCF appended to their file identifiers. The GLAS SDMP [Reference: Parent Document 2.1b] describes each of the GLAS Ancillary Data Product files and its format.

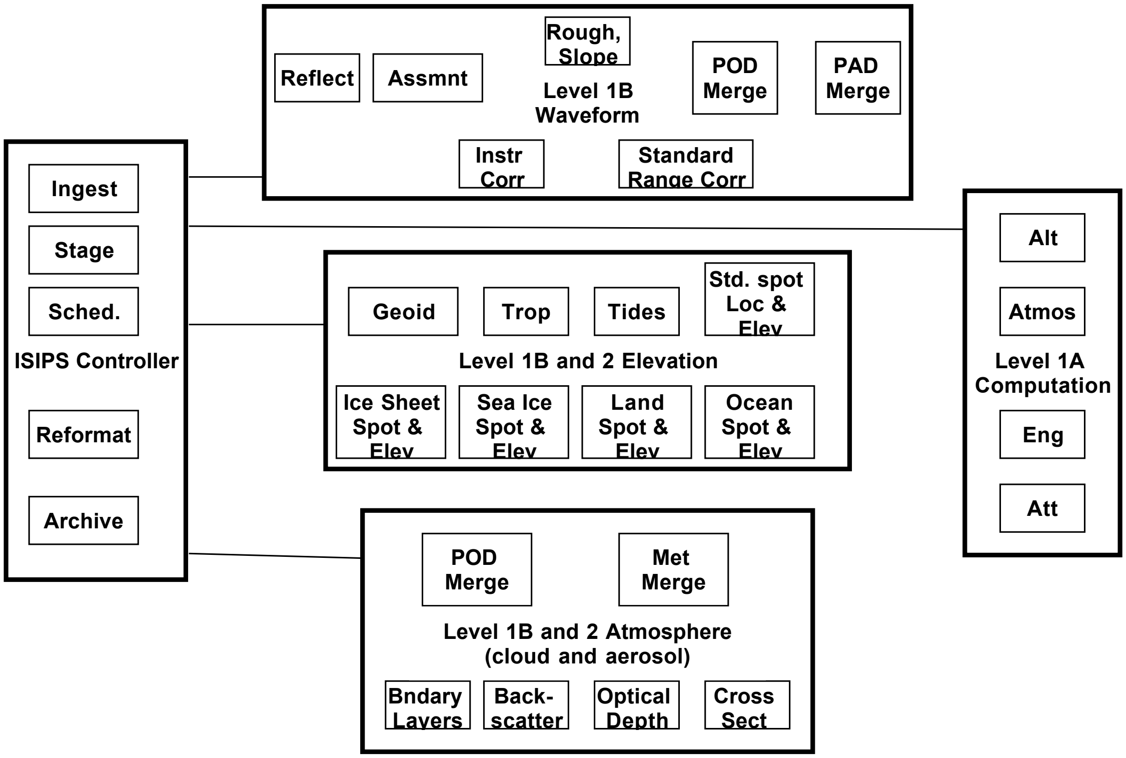

Figure 4-2 I-SIPS Software Top Level Decomposition

Table 4-2 Data File Usage

File ID	File Name	Output From Processes	Input To Processes
GLA01_SCF	Altimetry Data File	2	3
GLA02_SCF	Atmosphere Data File	2	4
GLA03_SCF	Engineering Data File	2	
GLA04_SCF	SRS and GPS Data File	2	
GLA05_SCF	Waveform-based Elevation Corrections File	3	5
GLA06_SCF	Elevation File	5	5
GLA07_SCF	Backscatter File	4	4
GLA08_SCF	Boundary Layer Height File	4	4
GLA09_SCF	Cloud Height for Multiple Layers File	4	4 5
GLA10_SCF	Aerosol Vertical Structure File	4	
GLA11_SCF	Thin Cloud/Aerosol Optical Depth File	4	5

Table 4-2 Data File Usage (Continued)

File ID	File Name	Output From Processes	Input To Processes
GLA12_SCF	Ice Sheet Products File	5	
GLA13_SCF	Sea Ice Products File	5	
GLA14_SCF	Land Products File	5	
GLA15_SCF	Ocean Products File	5	
GLA00	GLAS Instrument Packet File		2
GLA01	Altimetry Data File	1	
GLA02	Atmosphere Data File	1	
GLA03	Engineering Data File	1	
GLA04	SRS and GPS Data File	1	
GLA05	Waveform-based Elevation Corrections File	1	
GLA06	Elevation File	1	
GLA07	Backscatter File	1	
GLA08	Boundary Layer Height File	1	
GLA09	Cloud Height for Multiple Layers File	1	
GLA10	Aerosol Vertical Structure File	1	
GLA11	Thin Cloud/Aerosol Optical Depth File	1	
GLA12	Ice Sheet Products File	1	
GLA13	Sea Ice Products File	1	
GLA14	Land Products File	1	
GLA15	Ocean Products File	1	
GLA ANC 01	Meteorological Data File		4 5
GLA ANC 06	GLAS Metadata and Data Product Quality Data File	1 2 3 4 5	
GLA ANC 07	GLAS Coefficients and Constants File		1
GLA ANC 08	Precision Orbit Data File		4 5
GLA ANC 09	Precision Attitude Data File		5

Table 4-2 Data File Usage (Continued)

File ID	File Name	Output From Processes	Input To Processes
GLA ANC 12	Digital Elevation Map		5
GLA ANC 13	Geoid File		5
GLA ANC 14	Pole Tide Model File		5
GLA ANC 15	Earth Tide File		5
GLA ANC 16	Load Tide File		5
GLA ANC 17	Ocean Tide File		5
GLA ANC 18	Standard Atmosphere File		5
GLA ANC 19	Surface Type Class File		5
Control File	Processing/Reprocessing Control File		1

4.2.3 I-SIPS Software Components

The following subsections provide a high level description of the components of the I-SIPS Software. Included with the descriptions are the Data Flow Diagrams (DFD) of the components. More detailed definitions will be developed during the detailed design phase and will be documented in the GLAS I-SIPS Software Detailed Design Document. Figure 4-3 illustrates the I-SIPS Software overall data flow.

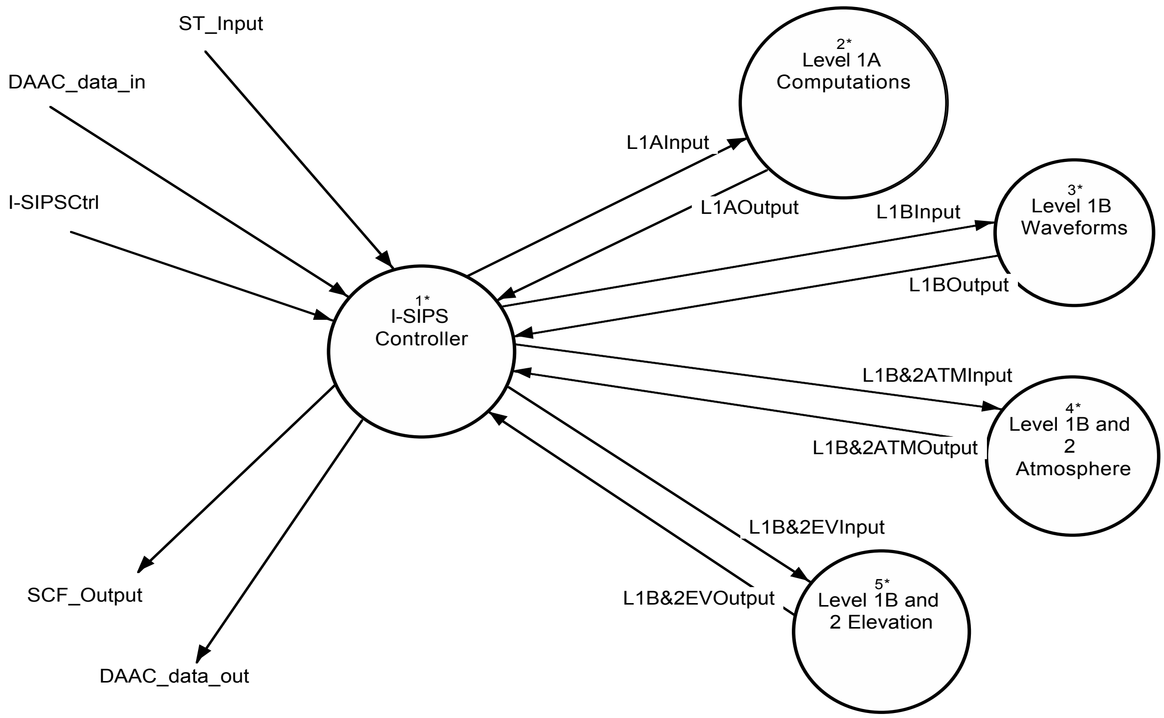

Figure 4-3 I-SIPS Software Data Flow Diagram

4.2.3.1 I-SIPS Controller

The I-SIPS software will be designed as an automated system and as such must have integrated data management and process control. The I-SIPS controller subsystem will manage all data from ingest through processing, archive and distribution. It will also schedule and control the science algorithm subsystems.

The I-SIPS controller subsystem is broken up into six processes as illustrated in Figure 4-4. The ingest process (1.1) will read, verify and catalog incoming Level 0 data and ancillary files from external sources. The cataloging function of the ingest process updates a file management database with pertinent metadata. The ingest process will then pass the data to the archive process (1.5) to be written to near-line storage. The staging system (1.2) will collect the data from the archive and place it on-line to prepare for processing. This process must communicate with the archive system to collect all necessary Level 0 and ancillary files. The scheduling system (1.3) controls the queuing and messaging of the process execution system. The process execution system (1.4) will execute the subsystems for the generation of all GLAS Standard Data

Products (SDP). The SDP will be passed to the archive system as they are completed by the individual processes. Data from the archive will be disseminated by the reformatting and distribution system (1.6). The SDP which are earmarked for DAAC distribution will be reformatted into HDF or HDF-EOS format and transferred. The internal SCF formatted data will be distributed to the science team.

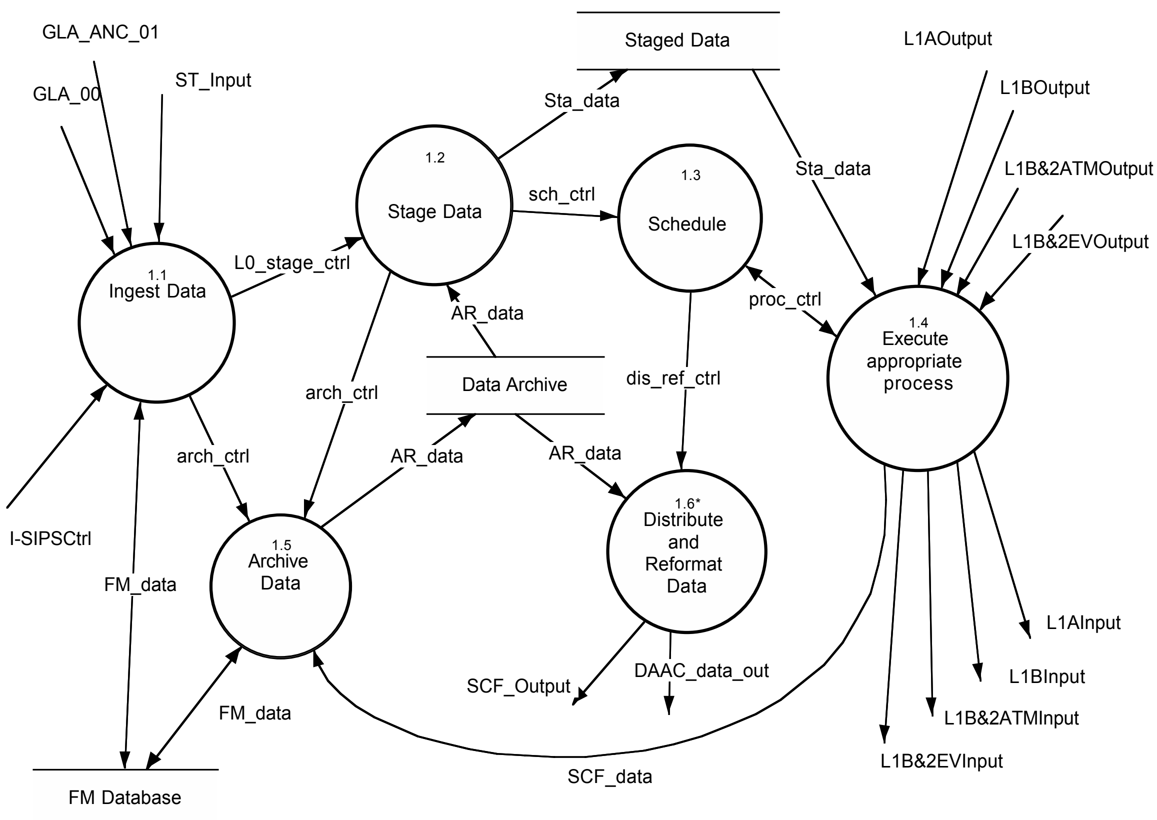

Figure 4-4 I-SIPS Controller Data Flow Diagram

4.2.3.2 Level 1A Computations

The function of the Level 1A Computations Subsystem is the generation of all Level 1A Standard Data Products (GLA01_SCF, GLA02_SCF, GLA03_SCF, and GLA04_SCF) and associated requisite information for metadata and quality assessment data (GLA ANC 06), Input instrument data is transformed from raw counts into engineering and science data (i.e., temperature, energy, distance, etc.). The Level 1A Standard Data Products are not geolocated and, since they are independent of each other, can be produced in parallel. The Level 1A algorithms must be able to automatically take care of flight software and hardware component switching within the GLAS instrument, for example, the proper calibration values must be used whether Laser A, B, or C is operating. The Algorithm Theoretical Basis Documents (ATBDs) produced by the Science Team are the authority for the processing algorithms utilized throughout this subsystem [Reference: Applicable Document TBD]. Figure 4-5 illustrates the data flow for the Level 1A Computations Subsystem.

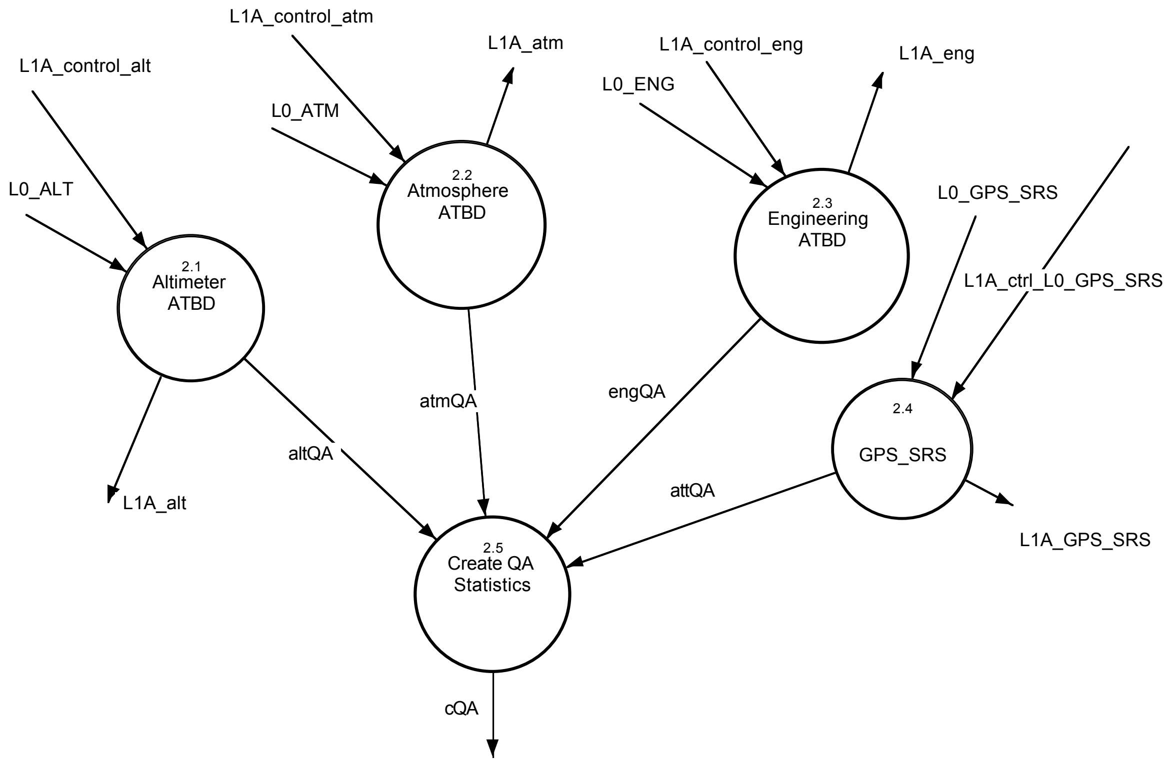

Figure 4-5 Level 1A Computation Data Flow Diagram

4.2.3.3 Level 1B Waveform Subsystem

The function of the Level 1B Waveform Subsystem is the generation of waveform-based information required to produce the elevation products and output to GLA05_SCF. This process will include all calculations involving the waveform and other instrument parameters which are required for characterizing the surface or for calculating the instrument range. A common methodology will be used for all waveforms. This will be for practicality and will be in consonance with the primary mission requirement of measuring ice sheet elevation. The methodology will be implemented using surface-type specific input from GLA_ANC 07 to generate instrument corrections based on either ice sheet, land, sea ice, or ocean algorithms. Also generated is the associated metadata and quality assessment data that will be output on GLA ANC 06. Figure 4-6 illustrates the data flow for this subsystem.

4.2.3.4 Levels 1B and 2 Atmosphere Computations Subsystem

The function of the Levels 1B and 2 Atmosphere Computations Subsystem is to create atmosphere parameters for the Standard Data Products and to generate associated metadata and quality assessment data. The quality assessment data are generated by each of the processes within the subsystem and combined in the Atmosphere QA Statistics Process (4.4) where they are output as contributions to GLA ANC 06. Atmosphere parameters are created for Level 1B product GLA07_SCF and Level 2 products GLA08_SCF, GLA09_SCF, GLA10_SCF, and GLA11_SCF. Atmosphere parameters are

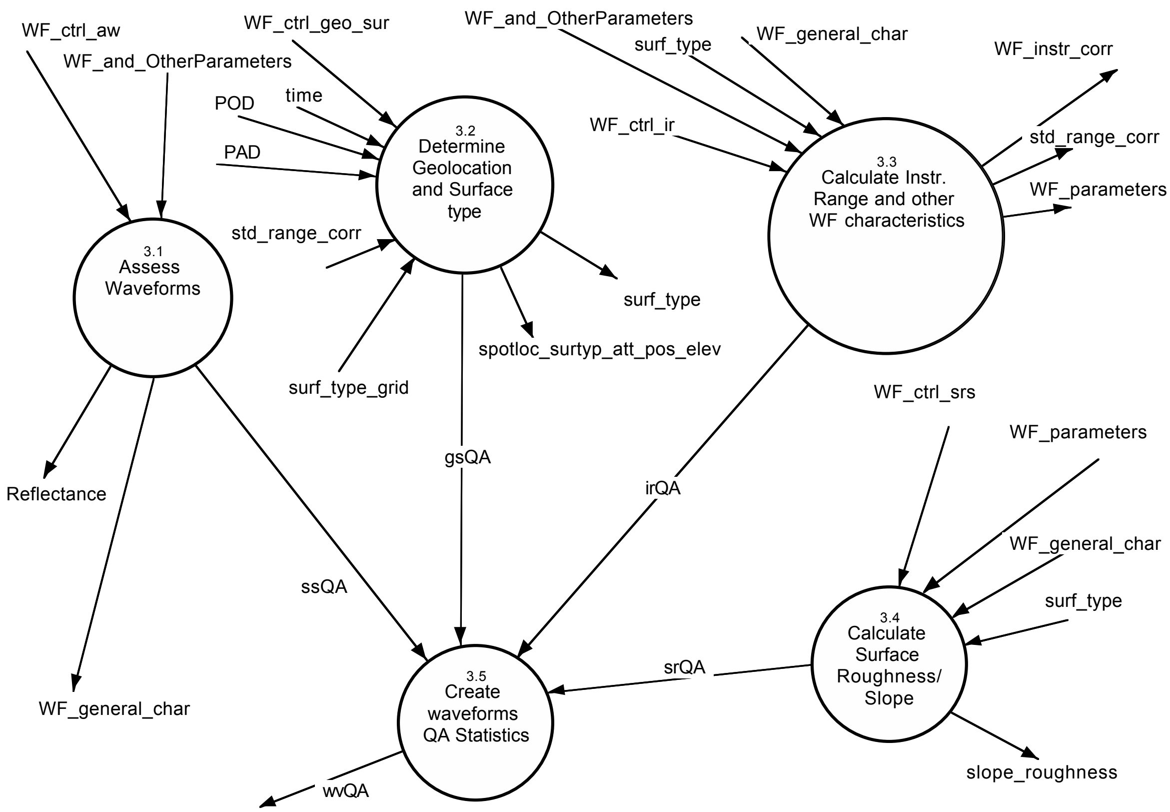

Figure 4-6 Level 1B Waveforms Data Flow Diagram

required to be geolocated. Therefore, this subsystem may not be executed until the Precision Orbit Determination (GLA ANC 08) is available. The Algorithm Theoretical Basis Documents (ATBDs) produced by the Science Team are the authority for the processing algorithms utilized throughout this process [Reference: Applicable Documents 2.2f, 2.2g, and 2.2h]. Figure 4-7 illustrates the processes and data flow for this subsystem.

4.2.3.4.1 Level 1B Backscatter Profile Process (4.1)

The function of the Level 1B Backscatter Profiles Process is to create parameters for the Level 1B calibrated backscatter Standard Data Product GLA07_SCF. This process geolocates the data and creates the attenuated backscatter cross section profiles. When the 532 nm backscatter data are saturated, the 1064 nm backscatter data are converted into 532 nm backscatter data and merged into the profile.

4.2.3.4.2 Level 2 Layer Heights Process (4.2)

The function of the Level 2 Layer Heights Process is to create parameters for the Level 2 PBL/aerosol layer height and cloud layer height Standard Data Products GLA08_SCF and GLA09_SCF. This process determines the planetary boundary layer (PBL) height and locates the top and bottom elevations of multiple aerosol and cloud layers. The layers are described at several resolutions

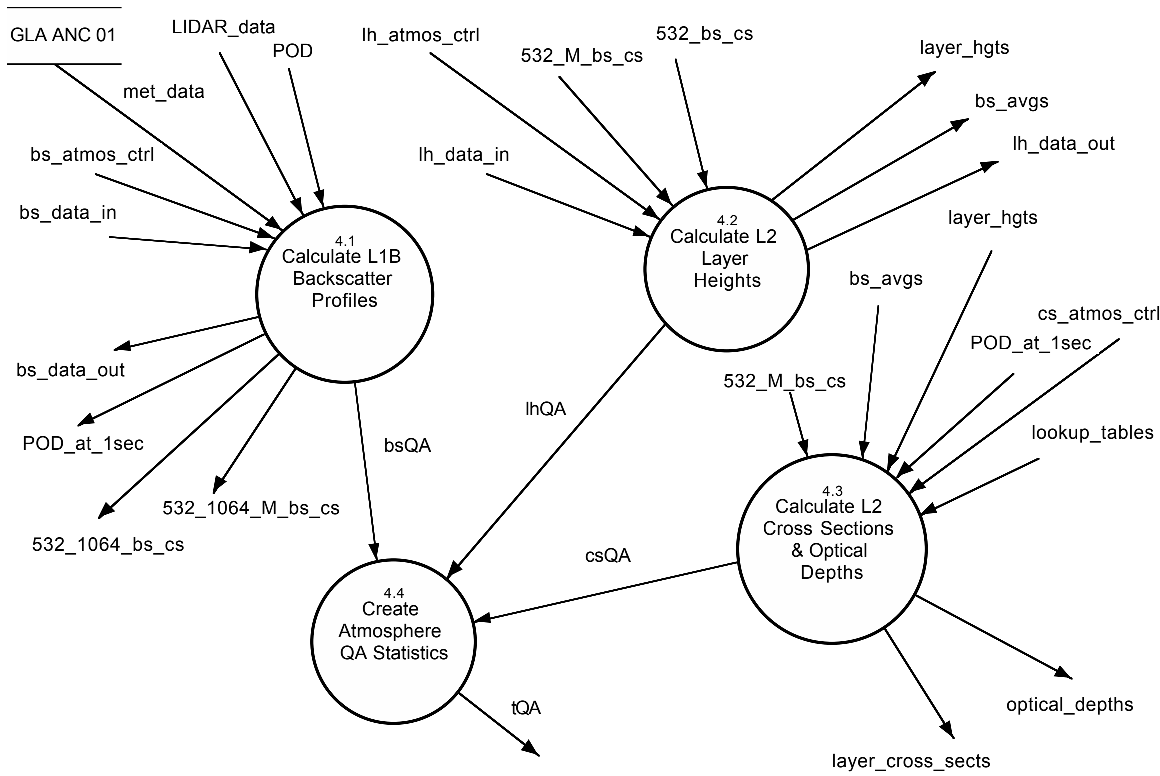

Figure 4-7 Level 1B and 2 Atmosphere Computations Data Flow Diagram

4.2.3.4.3 Level 2 Cross Sections and Optical Depth Process (4.3)

The function of the Level 2 Cross Sections and Optical Depths Process is to create parameters for the Level 2 cloud and aerosol backscatter cross section and optical depth Standard Data Products GLA10_SCF and GLA11_SCF. This process creates cross section profiles for cloud and aerosol attenuated backscatter, cloud absorption, and aerosol extinction. Additionally created are the optical depths of the multiple cloud and aerosol layers which are determined in the Level 2 Layer Heights Process (4.2.0). However, due to signal attenuation, cloud layer cross sections and optical depths are created only if the transmittance for the layer is above a threshold.

4.2.3.5 Level 1B and 2 Elevation Computation Subsystem

The function of the Levels 1B and 2 Elevation Computation Subsystem is the generation of all elevation Standard Data Products, associated Post Processing Quality Assessment data (GLA ANC 06), and related computations. The concept is to create parameters for a Level 1B time-ordered global product (GLA06_SCF) with a geodetically corrected surface-independent standard elevation; elevation corrections specific to each type of surface: ice sheet, sea ice, land, and ocean; and geodetic corrections for each observation. From this global product will be created parameters for the four region-specific Level 2 elevation products (GLA12_SCF, GLA13_SCF, GLA14_SCF, and GLA15_SCF), one each for ice sheet, sea ice, land, and ocean regions.

The elevation Standard Data Products are required to be geolocated; therefore, this subsystem may not be executed until the Precision Orbit Data and the Precision Attitude Data are available. The Algorithm Theoretical Basis Documents (ATBDs) produced by the Science Team are the authority for the processing algorithms utilized throughout this Subsystem [Reference: Applicable Documents 2.2g, 2.2i, 2.2j, and 2.2k]. Figure 4-8 illustrates the data flow for this Subsystem.

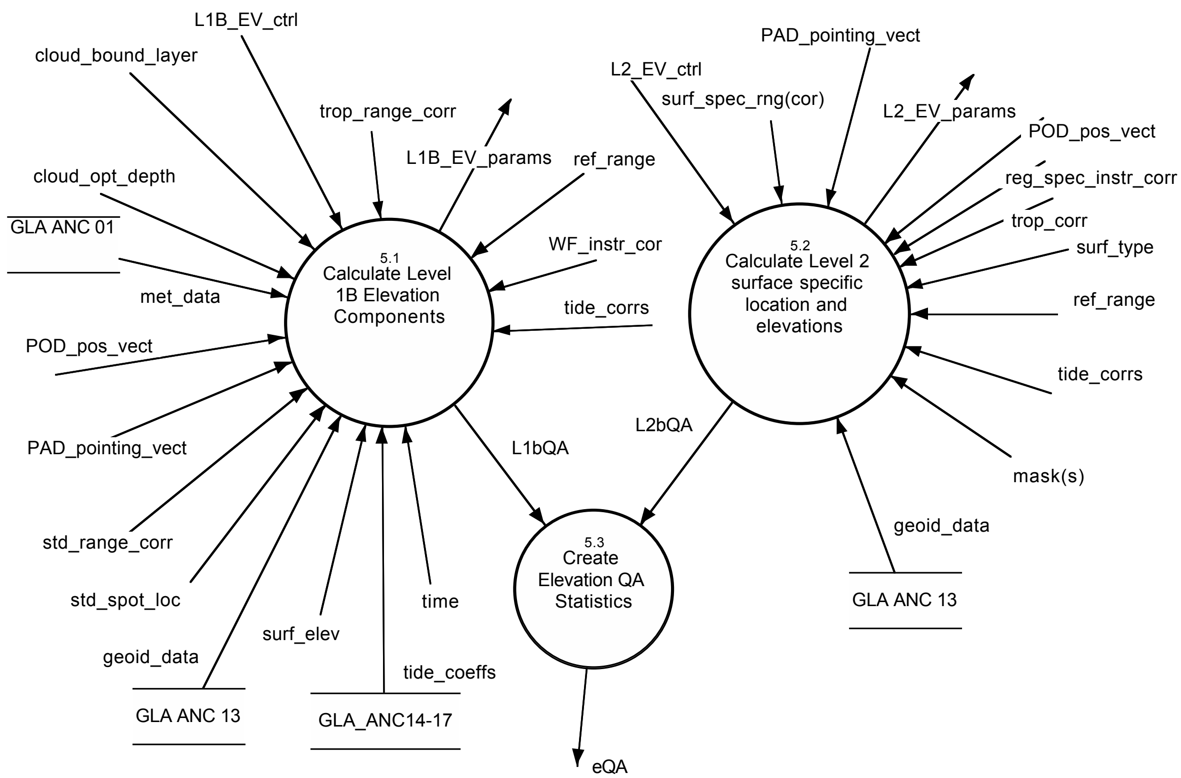

Figure 4-8 Level 1B and 2 Elevation Computations Data Flow Diagram

4.3 Processing

Nominal generation of the GLAS Level 1 and Level 2 Standard Data Products is defined as “Processing”. Complete processing is expected to occur over a span of three days. The first day after the Level 0 data are acquired, the non-geolocated Standard Data Products are generated. Since, it is expected to take 2 days to generate the POD and PAD ancillary files (GLA-ANC07 and 08), the third day after the Level 0 data are acquired, the geolocated Standard Data Products are generated. In addition, several other processing scenarios can be developed either by separating complete processing into discrete segments or performing processing for different reasons. Examples of additional processing scenarios are:

- Non-geolocated processing - produces only the non-geolocated Standard Data Products.

- Geolocated processing - produces only the geolocated Standard Data Products.
- Altimetry quicklook processing - produces all the altimetry Standard Data Products the first day after receipt of the Level 0 data using a predicted orbit.
- Atmosphere quicklook processing - produces all the atmospheric Standard Data Products the first day after receipt of the Level 0 data using a predicted orbit.

For each scenario, the controller will control which processes are executed and in what order. Table 4-3 lists example processing scenarios and the processes that are

Table 4-3 Processing Scenarios

Description	Processes	Input Files	Output Files
Complete processing	1 (all elements) 2 (all elements) 3 (all elements) 4 (all elements) 5 (all elements)	Control File GLA00 GLA ANC 01 GLA ANC 07 GLA ANC 08 GLA ANC 09 GLA ANC 12 GLA ANC 13 GLA ANC 14 GLA ANC 15 GLA ANC 16 GLA ANC 17 GLA ANC 18 GLA ANC 19	GLA01_SCF GLA02_SCF GLA03_SCF GLA04_SCF GLA05_SCF GLA06_SCF GLA07_SCF GLA08_SCF GLA09_SCF GLA10_SCF GLA11_SCF GLA12_SCF GLA13_SCF GLA14_SCF GLA15_SCF GLA ANC 06
Non-geolocated processing	1 (all elements) 2 (all elements) 3 (all elements)	Control File GLA00 GLA ANC 07	GLA01_SCF GLA02_SCF GLA03_SCF GLA04_SCF GLA05_SCF GLA ANC 06

Table 4-3 Processing Scenarios (Continued)

Description	Processes	Input Files	Output Files
Geolocated processing	1 (all elements) 4 (all elements) 5 (all elements)	Control File GLA02_SCF GLA05_SCF GLA ANC 01 GLA ANC 07 GLA ANC 08 GLA ANC 09 GLA ANC 12 GLA ANC 13 GLA ANC 14 GLA ANC 15 GLA ANC 16 GLA ANC 17 GLA ANC 18 GLA ANC 19	GLA06_SCF GLA07_SCF GLA08_SCF GLA09_SCF GLA10_SCF GLA11_SCF GLA12_SCF GLA13_SCF GLA14_SCF GLA15_SCF GLA ANC 06
Altimetry quicklook processing	1 (all elements) 2 2.1 2.5 3 (all elements) 5 (all elements)	Control File GLA00 GLA ANC 01 GLA ANC 07 GLA ANC 12 GLA ANC 13 GLA ANC 14 GLA ANC 15 GLA ANC 16 GLA ANC 17 GLA ANC 19 Predict Orbit Predict Attitude	GLA01_SCF GLA05_SCF GLA06_SCF GLA12_SCF GLA13_SCF GLA14_SCF GLA15_SCF GLA ANC 06
Atmosphere quicklook processing	1 (all elements) 2 2.2 2.5 4 (all elements)	Control File GLA00 GLA ANC 01 GLA ANC 07 GLA ANC 18 Predict Orbit	GLA02_SCF GLA07_SCF GLA08_SCF GLA09_SCF GLA10_SCF GLA11_SCF GLA ANC 06

required for the execution of each scenario. In Table 4-3, a Process number appended with the words “all elements” indicates that all lower level (child) processes of that process are executed. (The process numbers listed in Table 4-3 correspond to the software elements pictured in Figure 4-3 "I-SIPS Software Data Flow Diagram" on page 4-7.)

4.4 Reprocessing

It will be necessary to regenerate (i.e., Reprocess) all or part of the data products due to any of the following:

- updated ancillary files,
- revised engineering/calibration constants or coefficients,
- modified algorithms, or
- updated Standard Data Products that are inputs to processes which generate additional Standard Data Products.

Reprocessing incorporates some or all of the following types of file regeneration:

- Regeneration of all parameters of one or more Standard Data Products. The Standard Data Product is completely regenerated from all input files. The reprocessing flow is the same as the processing flow; all processes needed to make the original Standard Data Product must be executed to create the regenerated product. This type of reprocessing can be due to software algorithm changes or input file changes. For example, if a software change is implemented in the Level 1A algorithms, GLA01, GLA02, GLA03, and GLA04 would be completely regenerated from the GLA00.
- Regeneration of some parameters of one or more Standard Data Products using input Standard Data Products, input ancillary files, and the previous edition of the output Standard Data Product(s). The parameters to be updated are regenerated from input Standard Data Products and ancillary files, and the others are copied from the previous edition of the output Standard Data Product; a new output Standard Data Product is created. In this type of reprocessing, the input Standard Data Product(s) must be used to regenerate parameters because insufficient information is carried on the output Standard Data Product to do the regeneration. All unaffected parameters are copied from the previous edition of the output Standard Data Product to the new output Standard Data Product. This type of regeneration can occur because an algorithm or an input file (either a Standard Data Product or an ancillary file) is updated and the update affects only some parameters on the output Standard Data Product. Only those processes are executed that produce the updated parameters of the output Standard Data Product. For example, if GLA05_SCF (the Waveform-based Elevation Corrections File) were to be regenerated due to a modified waveform parameterization algorithm, the GLA01_SCF (the Level 1A Altimetry Data File), which contains the waveform information, would be used. Only those parameters on GLA05_SCF which were affected by the modified algorithm would be recomputed. Those parameters that were unaffected would be copied from the previous edition of the file (GLA05_Old).
- Regeneration of some of the parameters of one or more Standard Data Products using input ancillary files and the previous edition of the output Standard Data Product(s). Some parameters of the data product are regenerated from input ancillary files and the previous edition of the output Standard Data Product and the other parameters are copied from the previous edition of the Standard Data Product; a new output Standard Data Product is created. In this type of reprocessing, the parameters of the output Standard Data Product can

be regenerated without using the normal processing input Standard Data Product(s); there is sufficient information on the output Standard Data Product to update the affected parameters. All unaffected parameters are copied from the previous edition of the output Standard Data Product to the new output Standard Data Product. This type of reprocessing can occur because of algorithm or input ancillary file updates that affect only some parameters on the output Standard Data Product. Only those particular processes are executed that produce the updated parameters of the output Standard Data Product; the processes will be able to use the previous edition of the output Standard Data Product as input. For example, when an improved POD file (GLA ANC 08) is produced, GLA06_SCF would be regenerated by reprocessing only orbit-dependent parameters while copying unchanged parameters (e.g., reflectance data) from GLA06_Old, the previous edition of the version of GLA06_SCF. (GLA05_SCF would not be used.)

For each of these types of regeneration, reprocessing of a data product requires that other data products subsequently produced from that regenerated data product also be reprocessed. Those subsequently-produced data products may require complete or merely partial regeneration.

As discussed, reprocessing may require the execution of the complete I-SIPS Software or may require only the execution of selected processes. Table 4-4 lists the processes that are required for several sample Reprocessing Scenarios. (Numerous additional Reprocessing Scenarios will be defined during the Detailed Design phase.)

In Table 4-4, a process appended with the words “all elements” indicates that all lower level (child) processes of that process are executed. (The process numbers listed in Table 4-4 correspond to the software elements pictured in Figure 4-3 "I-SIPS Software Data Flow Diagram" on page 4-7.)

Reprocessing scenarios will be controlled by the controller. Common or expected scenarios will be defined during the Detailed Design phase and designed into the I-SIPS Software. However, the software will be designed to allow the controller to select any combination of processes to be executed, thereby allowing the implementation of unforeseen Reprocessing scenarios.

Table 4-4 Reprocessing Scenarios

Description	Processes	Input Files	Output Files
Regeneration of Level 2 Ice Sheet Data Products due to a software change in the Level 2 ice sheet products computation	1 (all elements) 5 5.2 (part related to ice sheet	Control File GLA06_SCF GLA ANC 06_Old GLA ANC 07	GLA12_SCF GLA ANC 06
Regeneration of Levels 1B and 2 Ice Sheet Data Products due to a modified retracking algorithm	1 (all elements) 3 (part related to ice sheet) 5 5.1 (part related to ice sheet 5.2 (part related to ice sheet	Control File GLA01_SCF GLA05_Old GLA06_Old GLA ANC 06_Old GLA ANC 07 GLA ANC 12 GLA ANC 13 GLA ANC 19	GLA05_SCF GLA06_SCF GLA12_SCF GLA ANC 06
POD file (GLA ANC 08) revision	1 (all elements) 5 (all elements)	Control File GLA06_Old GLA09_SCF GLA11_SCF GLA ANC 01 GLA ANC 06_Old GLA ANC 07 GLA ANC 08 GLA ANC 09 GLA ANC 12 GLA ANC 13 GLA ANC 14 GLA ANC 15 GLA ANC 16 GLA ANC 17 GLA ANC 18 GLA ANC 19	GLA06_SCF GLA12_SCF GLA13_SCF GLA14_SCF GLA15_SCF GLA ANC 06

Section 5

External Interface Design

External interfaces are defined as those system and human interfaces which are external to the software system. This section describes the external interfaces illustrated in Figure 4-1 "I-SIPS Software Conceptual Architecture" on page 4-1.

For the I-SIPS Software, interfaces exist between the software and the following external users:

- The GLAS Science Team
- The I-SIPS Team
- The EOSDIS DAAC

Each external interface is described below. As appropriate, information for each interface includes a description of the interface, expected responses, error handling and recovery accommodations, and constraints imposed on the software implementation by the interface. The I-SIPS Software's external interfaces to the EOSDIS DAAC comply with applicable ESDIS protocols and conventions.

5.1 The GLAS Science Team Interface

The Science Team provides required ancillary files for input to the I-SIPS Software, and reviews the Standard Data Products generated by the I-SIPS Software. The Science Team creates the Precision Orbit Data File (GLA ANC 08) and the Precision Attitude Data File (GLA ANC 09), and provides updates for the GLAS Coefficients and Constants File (GLA ANC 07). (Any Instrument Team constants will also be provided through this interface.) Table 5-1 lists the Standard Data Products files and the Ancillary Data Products files which comprise the Science Team interface.

Table 5-1 Science Team External Interface Files

I-SIPS Software Data Flow	Data File ID	Data File Name
Input	GLA ANC 08 GLA ANC 09 GLA ANC 07	Precision Orbit Data File Precision Attitude Data File GLAS Coefficients and Constants File
Output	all Standard Data Products	all GLAS Standard Data Products

Science Team members or their designated representatives initiate all processes within this interface, based upon availability of inputs. All file deliveries and retrievals involving the ICESat SCF are performed using standard UNIX file transfer commands.

The following responses are expected to occur within the Science Team:

- Upon availability of inputs, the ancillary files are created under the direction of the Science Team. After verification and validation of the ancillary files, the I-SIPS Team is notified that the ancillary files are available for transfer to the ICESat SCF.
- Upon availability of the GLAS standard data products, product validation will be performed under the direction of the Science Team.
- The Science Team provides the GLAS Coefficients and Constants File (GLA ANC 07). The I-SIPS Team keeps this file under configuration management control.

5.2 The I-SIPS Team Interface

The I-SIPS Team initiates the execution of the I-SIPS Software and delivers the standard data products to the DAAC. The I-SIPS Team updates the GLAS Metadata and Data Product Quality Data File (GLA ANC 06) during Post-Processing Metadata Generation, and delivers the file and any additional metadata to the DAAC for GLAS standard product update. The I-SIPS Team formats files designated for DAAC delivery using the Project-provided SDP Toolkit. Table 5-2 lists the Standard Data Products files and the Ancillary Data Products files which comprise the I-SIPS Team interface.

Table 5-2 I-SIPS Team External Interface Files

I-SIPS Software Data Flow	Data File Name	Data File Description
Input	Control File	Processing/Reprocessing Control File

The I-SIPS Team initiates all processes within this interface, based upon availability of inputs.

The following responses are expected to occur within the I-SIPS Team:

- After notification of availability by the Science Team, the I-SIPS Team transfers the Precision Orbit Data File and the Precision Attitude Data File to the ICESat SCF in preparation for I-SIPS Software execution.
- The I-SIPS Team retrieves additional ancillary files from the DAAC.
- Upon availability of all input files, the I-SIPS Team initiates the I-SIPS Software execution.
- The I-SIPS Team monitors the execution of the I-SIPS Software to determine normal or abnormal termination.
- Upon normal termination of the I-SIPS Software, the I-SIPS Team validates the GLAS standard data products under the direction of the Science Team.

- The I-SIPS Team archives the standard data products and the ancillary data products used during the I-SIPS execution on the ICESat SCF and delivers the products to the EOSDIS DAAC.
- Upon abnormal termination of the I-SIPS Software, the I-SIPS Team performs recovery procedures as specified by the SDS Development Team.
- If file transfers between the ICESat SCF and DAAC fail, the I-SIPS Team will perform recovery as specified by the ESDIS.
- The I-SIPS Team will initiate reprocessing of the data products as required.

5.3 The EOSDIS DAAC Interface

The DAAC represents the ESDIS Project operational facilities, consisting of various computer hardware nodes and network access arrangements. All GLAS standard data products and ancillary data will be delivered to the DAAC for archive. Ancillary data to be used as input to the I-SIPS Software will be available from the DAAC. All file transfers between the ICESat SCF and the DAAC will be performed following ESDIS guidelines and procedures. Table 5-3 lists the Standard Data Products files and the Ancillary Data Products files which comprise the EOSDIS DAAC interface.

Table 5-3 EOSDIS DAAC External Interface Files

I-SIPS Software Data Flow	Data File Name	Data File Description
Input	GLA00 GLA ANC 01	GLAS Instrument Packet File Meteorological Data File
Output	all Standard Data Products all Ancillary Data Products	all GLAS Standard Data Products files all GLAS Ancillary Data Products

5.4 External Interface Requirements Allocation

Section 6 describes the allocation of all software requirements, including the external interface requirements, delineated in the GLAS SSRD [Reference: Parent Document 2.1c].

Section 6

Requirements Allocation and Traceability

This section traces the allocation of the software requirements from the GLAS SSRD [Reference: Parent Document 2.1c] to the architectural design presented in this document. The GLAS SSRD enumerates both the I-SIPS Software Requirements and the GLAS Instrument Support Terminal (IST) Software requirements. The software requirements specific to the GLAS IST are neither implemented in the I-SIPS software nor addressed in this document.

In the tables that follow, the prefix 'GSDS' represents the requirements applicable to the GLAS Standard Data Software, which consists of both the I-SIPS Software and the GLAS Instrument Support Terminal (IST) Software. The prefix 'GSDP' refers to the requirements which are specific to the I-SIPS Software (GLAS Standard Data Product generation).

Table 6-1 lists the requirement numbers, their descriptions, and the section number(s) within this document which provide text and/or diagrams fulfilling the requirement. In addition, Table 6-1 indicates whether the requirement is original (defined in the software requirements document), derived (during the architectural design process), or a goal.

Table 6-1 Requirements Description and Traceability to Architectural Design

Requirement Number	Description	Section Number	Status
GSDS-00200	Requisite GLAS data and ancillary data files must be available prior to the generation of a standard data product as specified by the GLAS Data Management Plan.	4.2.3.4 4.2.3.5	original
GSDS-01200	All software development for the GLAS Standard Data Software shall follow a well-defined software life cycle plan with adequate documentation generated and reviews held. The approach taken shall follow the guidelines of the NASA Software Engineering Program (NSEP), to define and document requirements thoroughly before beginning design, and to use prototyping to refine requirements, verify critical areas of the design, and mitigate any higher risk elements.	3.1.2	original
GSDS-01400	The Standard Data Software will interface with the Science Team, I-SIPS Team, Instrument Operations Team, the EOC, the EOSDIS DAAC, the GLAS IST, and the GLAS SCF. The Standard Data Software will interface with the standard data products, ancillary input data, and files supporting instrument operations.	5.1 5.2 5.3	original

Table 6-1 Requirements Description and Traceability to Architectural Design (Continued)

Requirement Number	Description	Section Number	Status
GSDS-01600	The Standard Data Software shall adhere to ESDIS requirements when interfacing to the Project facilities to deliver or retrieve files.	5.3	original
GSDS-01800	Adequately define and document the requirements and the design of the SDS so that a programmer unfamiliar with the software can easily maintain or modify it.	3.1.2	goal
GSDS-01900	By following a well-defined life cycle for software development, implement software that is highly reliable and maintainable.	3.1.1	original
GSDP-30100	The I-SIPS Software will create GLAS standard products that are to be delivered to the DAAC in the format agreed to by ESDIS.	3.2 3.3.1	original
GSDP-30101	The GLAS Level 1 standard data products delivered to the DAAC will be formatted as HDF.	3.2	derived
GSDP-30102	The GLAS Level 2 standard data products delivered to the DAAC will be formatted as HDF-EOS.	3.2	derived
GSDP-30300	The EDOS collected Level 0 data will be provided from the EOSDIS DAAC to the I-SIPS.	4.2.3.2	original
GSDP-30400	The I-SIPS Team shall ensure the availability and integrity of the ancillary data files necessary to produce the GLAS standard data products.	5.2	original
GSDP-30600	The I-SIPS Software will create the GLAS Level 1A data from the Level 0 GLAS instrument data products.	4.2.3.2	original
GSDP-30601	The I-SIPS Software will automatically handle flight software and instrument hardware configuration and mode changes during Level 1A processing.	4.2.3.2	derived
GSDP-30700	The I-SIPS Software will create the GLAS Level 1B data from GLAS Level 1A or 1B data and ancillary data.	4.2.3.3 4.2.3.4 4.2.3.5	original
GSDP-30800	The I-SIPS Software will create the GLAS Level 2 data from the Level 1B or Level 2 data and ancillary data.	4.2.3.4.2 4.2.3.4.3 4.2.3.5.2	original
GSDP-30900	Metadata will include an assessment of the software performance.	4.1.1	original
GSDP-31000	The I-SIPS Software shall accept as input: the GLAS instrument packet data, the GLAS standard data products and ancillary data.	4.2.3	original
GSDP-31100	The I-SIPS Software shall produce metadata describing the data products and their quality.	4.2.3	original

Table 6-1 Requirements Description and Traceability to Architectural Design (Continued)

Requirement Number	Description	Section Number	Status
GSDP-31101	Produce the metadata or its prerequisite information while generating the data products and store in a location accessible to the I-SIPS Software.	4.2.3	derived
GSDP-31200	The I-SIPS Software shall properly implement the science algorithms as specified in the Algorithm Theoretical Basis Documents.	4.2.3.2 4.2.3.4 4.2.3.5	original
GSDP-31300	Automatic or manual Quality Assurance (QA) is provided for each standard data product and ancillary file. Until QA is completed, the file shall be marked as unvalidated. Upon successful completion of QA, the file shall be marked as validated.	4.2.2 4.2.3	original
GSDP-31500	The I-SIPS Software will be implemented such that it will require minimal modifications in order to port the software to another hardware system.	3.2	original
GSDS-31601	Software shall be divided into multiple independent subsystems such that multiple processors can be used to execute the entire I-SIPS Software system.	4.2	derived
GSDP-31602	To improve efficiency during processing, the I-SIPS software will store the data products as non-HDF intermediate files.	4.2.2	derived
GSDP-31603	To improve efficiency for processing and updating elevation parameters store time ordered global elevation data and corrections in one location.	4.2.3.5.1	derived
GSDP-31701	The Level 1B data requiring geolocation will not be created until the Precision Orbit and Precision Attitude data are available.	4.2.3.4.1 4.2.3.5.1	derived
GSDP-31800	The I-SIPS Software shall incorporate sufficient data and process error handling for error detection, isolation, and recovery.	4.2.3.6	original
GSDP-31900	The implemented I-SIPS Software shall be reliable.	3.1.1	original
GSDP-32000	The implemented I-SIPS Software shall be maintainable.	3.1.1	original
GSDP-32001	Constants and coefficients used by the I-SIPS Software shall be easily controlled and modifiable without changing compiled code.	4.2.3	derived
GSDP-32002	I-SIPS Software common functions and utilities will be implemented in libraries to reduce redundant code generation and improve maintainability.	3.3	derived

Table 6-1 Requirements Description and Traceability to Architectural Design (Continued)

Requirement Number	Description	Section Number	Status
GSDP-32200	Due to input data updates or processing software changes, the I-SIPS Software shall be capable of reprocessing entire or selected parameters on GLAS standard data product(s).	4.4	original
GSDP-32201	Group processes by ATBDs and their related functions to facilitate selective reprocessing.	4.4	derived
GSDP-32202	The I-SIPS Software shall be controlled so that selected processes can be turned on and off as desired.	4.4	derived

Table 6-2 lists the architectural design document sections and their source requirements.

Table 6-2 Architectural Design Sections and their Source Requirements

Architectural Design Section Name	Section Number	Requirement Number(s)
Rationale for the Design Approach	3.1.1	GSDS-01900 GSDP-31900 GSDP-32000
Approach to Managing the Design Effort	3.1.2	GSDS-01200 GSDS-01500 GSDS-01700 GSDS-01800
Design Decision and Tradeoffs	3.2	GSDP-30100 GSDP-30101 GSDP-30102 GSDP-31500
Architectural Drivers	3.3	GSDP-32002
Science Drivers	3.3.1	GSDP-30100
External Interface Data	4.1.1	GSDP-30900 GSDP-31300
Logical Architecture	4.2	GSDP-31601
Software Data Files	4.2.2	GSDP-31300 GSDP-31602

Table 6-2 Architectural Design Sections and their Source Requirements

Architectural Design Section Name	Section Number	Requirement Number(s)
I-SIPS Software Components	4.2.3	GSDP-32001
I-SIPS Controller (1)	4.2.3.1	GSDP-30900 GSDP-31000 GSDP-31100 GSDP-31101 GSDP-31300
Level 1A Computations (2)	4.2.3.2	GSDP-30300 GSDP-30600 GSDP-30601 GSDP-30900 GSDP-31000 GSDP-31100 GSDP-31101 GSDP-31200 GSDP-31300
Level 1B Waveform Subsystem (3)	4.2.3.3	GSDP-30700 GSDP-30900 GSDP-31000 GSDP-31100 GSDP-31101
Levels 1B and 2 Atmosphere Computations Subsystem (4)	4.2.3.4	GSDP-30700 GSDP-30900 GSDP-31000 GSDP-31100 GSDP-31101 GSDP-31200 GSDP-31300
Level 1B Backscatter Profile Process (4.1)	4.2.3.4.1	GSDS-00200 GSDP-31701
Level 2 Layer Height Process (4.2)	4.2.3.4.2	GSDS-00200 GSDP-30800
Level 2 Cross Section and Optical Depth Process (4.3)	4.2.3.4.3	GSDS-00200 GSDP-30800

Table 6-2 Architectural Design Sections and their Source Requirements

Architectural Design Section Name	Section Number	Requirement Number(s)
Levels 1B and 2 Elevation Computations Subsystem (5)	4.2.3.5	GSDS-00200 GSDP-30700 GSDP-30800 GSDP-30900 GSDP-31000 GSDP-31100 GSDP-31101 GSDP-31200 GSDP-31300 GSDP-31603 GSDP-31701
Reprocessing	4.4	GSDP-32200 GSDP-32201 GSDP-32202
The GLAS Science Team Interface	5.1	GSDS-01400
The I-SIPS Team Interface	5.2	GSDS-01400 GSDP-30400
The EOSDIS DAAC Interface	5.3	GSDS-01400 GSDS-01600

Section 7

Partitioning for Incremental Development

The I-SIPS Software is planned for a phased delivery to the Project, based on the spacecraft launch schedule and the investigation Statement of Work. The I-SIPS Software is to be delivered in three delivery milestones. Table 7-1 defines the three required I-SIPS Software deliveries and the functions to be implemented in each delivery. The content of the deliveries is defined in the software management plan. Included in the deliveries will be the ESDIS-required fixed metadata that includes a description of the GLAS mission and instrument.

Table 7-1 Delivery Schedule and Description

Delivery Name	Delivery Date	Delivery Description
V0 (Beta)	May 1999	The framework of the I-SIPS Software will be in place, with interfaces for inputs/outputs.
V1	May 2000	All major functions and interfaces (including standard error and message services) will be incorporated. Any fixes required from the V0 version will have been implemented. All ATBDs will be implemented.Will exercise the SDP Toolkit interfaces to the SDF.
V2	December 2000	The complete, verified operational I-SIPS Software in place. Any fixes required from the V1 version will have been implemented. Final pre-launch updates to calibration equations will be implemented.

Abbreviations & Acronyms

ALT	ALTimeter
ATBD	Algorithm Theoretical Basis Document
ATM	Airborne Topographic Mapper
CASE	Computer-Aided Software Engineering
CSC	Computer Software Component
CSCI	Computer Software Configuration Item
CSU	Computer Software Unit
COTS	Commercial Off-the-Shelf (Software)
DAAC	Distributed Active Archive Center
DFD	Data Flow Diagram
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
ERS	European Remote Sensing (Satellite)
ESDIS	Earth Science Data and Information System Project
GEOSAT	GEOdetic SATellite
GFO	GEOSAT Follow On
GIST	GLAS Instrument Support Software
GLAS	Geoscience Laser Altimeter System
GPS	Global Positioning System
GSDS	GLAS Standard Data Software
GSFC	Goddard Space Flight Center (at Greenbelt, Maryland)
HDF	Hierarchal Data Format
HP	Hewlett Packard
I-SIPS	ICESat Science Investigator-led Processing System
ICESat	Ice, Cloud, and land Elevation Satellite
ISADD	I-SIPS Software Architectural Design Document
ISDDD	I-SIPS Software Detailed Design Document
ISS	I-SIPS Software

IST	Instrument Support Terminal
Laser	Light Amplification by Stimulated Emission of Radiation
Lidar	LIght Detection And Ranging
MOLA	Mars Orbiter Laser Altimeter
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
PAD	Precision Attitude Determination
POD	Precision Orbit Determination
QA	Quality Assessment
SCF	Science Computing Facility
SDD	Software Development Database
SDMP	Science Data Management Plan
SDP	Science Data Production or Science Data Processor
SDS	Standard Data Software
SDT	SDS Development Team
SLA	Shuttle Laser Altimeter
SSMP	Science Software Management Plan
SSRD	Science Software Requirements Document
TBD	To Be Determined, To Be Done, or To Be Developed
WFF	Wallops Flight Facility

Glossary

ECS	The EOSDIS Core System; the central structure of the ESDIS Project consisting of the Flight Operations Segment, the Science Data Processing Segment, and the Communications and System Management Segment. The ECS encompasses the EOS Operations Center, the EOS Data and Operations System, and the ISTs in the Flight Operations Segment. The Science Data Processing Segment consists primarily of the Distributed Active Archive Centers providing science data processing, data archival, data base, and client support services.
ESDIS	The Earth Science Data and Information System Project; charged with the implementation and support of the Earth Observing System and Earth Science Enterprise programs through the Earth Observing System Data and Information System. The parent organization overseeing the implementation and operation of the ECS.
file	A collection of data stored as records and terminated by a physical or logical end-of-file (EOF) marker. The term usually applies to the collection within a storage device or storage media such as a disk file or a tape file. Loosely defined, it is used to indicate a collection of GLAS data records without a standard label. For the Level 1A Data Product, the file would constitute the collection of one-second Level 1A data records generated in the SDPS working storage for a single pass.
header	A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.
IST	The GLAS Instrument Support Terminal; a workstation or a collection of workstations established for mission support and instrument command and performance monitoring by the GLAS investigation, specifically the GLAS Instrument Engineering and I-SIPS Teams.
label	The text and/or binary information records, record set, block, header, or headers prefacing a data file or linked to a data file sufficient to form a labeled data product. A standard label may imply a standard data product. A label may consist of a single header as well as multiple headers and markers depending on the defining authority.
Level 0	The level designation applied to an EOS data product that consists of raw instrument data, recorded at the original resolution, in time order, with any duplicate or redundant data packets removed.
Level 1A	The level designation applied to an EOS data product that consists of reconstructed, unprocessed Level 0 instrument data, recorded at the full resolution with time referenced data records, in time order. The data are annotated with ancillary information including radiometric and geometric calibration coefficients, and georeferencing parameter data (i.e., ephemeris data). The included, computed coefficients and parameter data have not, however, been applied to correct the Level 0 instrument data contents.

Level 1B	The level designation applied to an EOS data product that consists of Level 1A data that have been radiometrically corrected, processed from raw data into sensor data units, and have been geolocated.
Level 2	The level designation applied to an EOS data product that consists of derived geophysical data values, recorded at the same resolution, time order, and geo-reference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geo-physical data values derived from Level 1 or Level 2 data, recorded at a temporally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.
metadata	The textual information supplied as supplemental, descriptive information to a data product. It may consist of fixed or variable length records of ASCII data describing files, records, parameters, elements, items, formats, etc., that may serve as catalog, data base, keyword/value, header, or label data. This data may be parsable and searchable by a tool or utility program.
product	Specifically, the Data Product or the EOS Data Product. This is implicitly the labeled data product or the data product as produced by software on the SDPS or SCF. A GLAS data product refers to the data file or record collection either prefaced with a product label or standard formatted data label or linked to a product label or standard formatted data label file. It may indicate a single pass file aggregation, or the entire set of product files contained in a data repository.
record	A specific organization or aggregate of data items. It represents the collection of EOS Data Parameters within a given time interval, such as a one-second data record. It is the first level decomposition of a product file.
SCF	The GLAS Science Computing Facility; a collection of workstations operated by the GLAS Science Team and the Science Team Leader at their respective institutions and agencies. These workstation nodes are provided by the ESDIS Project and are operated under the jurisdiction of both the ESDIS Project and the GLAS Science Team.
Standard Data Product	Specifically, a GLAS Standard Data Product. It represents an EOS ALT-L/GLAS Data Product produced on the EOSDIS SDPS for GLAS data product generation or within the GLAS Science Computing Facility using EOS science community approved algorithms. It is routinely produced and is intended to be archived in the EOSDIS data repository for EOS user community-wide access and retrieval.
Terminator	External interface to a function.